TECHNOLOGY NEEDS/OPPORTUNITIES STATEMENT

PROCESS TECHNOLOGY FOR DRYING SPENT NUCLEAR FUEL

Identification No.: RL-SNF-15
Date: May 2001

Program: Spent Nuclear Fuels (SNF)
OPS Office/Site: Richland Operations Office/Hanford Site
PBS No.: RL-RS03
Waste Stream: SNF-02 Dry K Basin Fuel
TSD Title: N/A
Operable Unit (if applicable): N/A
Waste Management Unit (if applicable): N/A
Facility: Cold Vacuum Drying Facility, Canister Storage Building

***Priority Rating*:**

This entry addresses the "Accelerated Cleanup: Paths to Closure (ACPC)" Priority: Select a "1", "2" or "3" to assess the impact of the need/opportunity relative to the current site baseline.

____ 1. Critical to the success of the ACPC
_X_ 2. Provides substantial benefit to ACPC projects (e.g., moderate to high lifecycle cost savings or risk reduction, increased likelihood of compliance, increased assurance to avoid schedule delays)
____ 3. Provides opportunities for significant, but lower cost savings or risk reduction, and may reduce uncertainty in ACPC project success.

***Need Title*:** Process Technology for Drying Spent Nuclear Fuel

Need/Opportunity Category: *Technology Opportunity* -- The site desires an alternative to the current baseline technology / process.

***Need Description*:**
A high through put drying process (improved over current vacuum drying technology) and the scientific/kinetic data to justify safe implementation are needed in order to process N reactor metallic uranium fuel.

The Hanford Spent Nuclear Fuel Project is addressing the urgent need to move spent fuel from the present degraded wet storage conditions in the 105 K East (KE) and the 105 K West (KW) Basins in the 100 K Area on Hanford's Central Plateau. About 80% (by weight) of the entire U.S. Department of Energy's (DOE) Spent Nuclear Fuel inventory is located at the Hanford K Basins. Fuel stored in the basins exists in a degraded state and continues to corrode. The Spent Nuclear Fuel Project is removing the spent fuel from the water storage in the K-Basins, applying a cold vacuum drying (CVD) process and placing the fuel into interim dry storage until a national geologic repository is available.

To meet schedule commitments, the work in progress must be accelerated. It is anticipated and expected that operations will become more efficient with time as the project gains experience with the fuel handling/processing systems. However, there may be ways to improve the current fuel drying process that have not been evaluated and there might also be alternatives to the cold vacuum drying process that could reduce the time to complete fuel drying.

Schedule Requirements:

Earliest Date Required: 10/1/2002
Latest Date Required: 06/01/2003

The spent fuel presently stored in the K-Basins must be removed from the basins, packaged, dried, and transferred to the Canister Storage Building by July 31, 2004 (TPA milestone M-34-18B, and DNFSB Commitment Number 118E). Early demonstration of alternative fuel drying strategies is desirable.

Problem Description**:** Presently, the steps for cold vacuum drying (CVD) of the fuel contained in MCOs may be summarized as:

1. The void space in each MCO is initially full of basin water when a MCO arrives at the CVDF. The MCO is first heated to about 50°C using this water as a heat transfer media.
2. The majority of the free water is then removed by pressurizing the MCO with inert gas. The water is removed via a dip tube that reaches from the top of the MCO to the bottom.
3. The vacuum drying process is initiated while heat is continually applied to the MCO by a water-filled heating jacket to keep the contents near 50°C. The vacuum is maintained for about 16 hours.
4. Following vacuum drying the MCO is isolated from the vacuum system and a “pressure rebound” test is performed. This is simply a test to observe the rise in pressure that may arise as any residual water turns to gas at the reduced pressure within the MCO.
5. The MCO is then purged with helium gas for several hours, evacuated again, and then subjected to another pressure rebound test.
6. Following purging and successful completion of the rebound tests, the MCO is sealed and transferred from the CVDF to the CSB for interim storage.

Operational improvements may be possible by increasing the temperature at which the drying is conducted. However, the potential accident scenarios evaluated during the development of the Safety Basis for the Safety Analysis Report (SAR) for the CVDF established the temperature presently used. These accidents included the potential for run-away oxidation events involving breached/corroded fuel elements, fuel pieces, scrap, and sludge particulates during drying when any exposed uranium metal could potential react with water vapor.

The understanding of the reactivity of the water stored and degrade uranium fuel found in the K-Basins is limited. Literature data regarding the oxidation of uranium have a large standard deviation, and most reported data are for unirradiated uranium that has not been stored in water. It is known the damaged/degraded K-Basin fuel is cracked and fissured and contains uranium hydride. Limited characterization data obtained by the project in the 1990s suggests the degraded fuel may react more rapidly than unirradiated uranium, but the large scatter of the literature data makes a conclusion regarding the expected performance of the K-Basin fuel difficult. Thus, the project had to develop the drying process with sufficient conservatism (i.e. a relatively low drying temperature) to insure the safety of the system.

To reduce the conservatism in the drying temperature, additional data regarding the oxidation rate of water-stored and degraded uranium in water vapor is needed. If it can be shown the oxidation rate of the uranium in water vapor at temperatures between 50 and 100°C is not significantly different from literature values, then it may be possible to justify a rise in the drying temperature. The time to dry a MCO could be reduced by several hours to one day if the drying temperature could be raised by 10 to 25°C.

Additional schedule improvements can be achieved if alternative-drying techniques can be employed. The CVD process for drying uses a vacuum to reduce the risk of uranium oxidation events. While this insures safety for the drying of breached and degraded fuel elements, it is known (through extensive in-basin visual examinations and from the handling of the fuel loaded into the first ten MCOs) that a vast majority of the fuel elements contained in the K-Basins are virtually intact. These intact fuel elements have no or little exposed uranium and do not pose a reactivity problem that would jeopardize safety. Because each fuel element is inspected prior to loading in a MCO, it is possible to load entire MCOs with intact fuel. It may be possible to dry these MCOs using a flowing gas process that does not require a complicated vacuum system. Removal of these MCOs from the CVD process could save substantial amounts of time. It is estimated that up to 80% of the fuel elements in the K-Basins may be intact. The CVD process could be used to dry damaged fuel, scrap, and sludge particulates, while an alternative process could be used to dry the intact fuel elements.

Proposed improvements to the process must be accompanied by sufficient data to ensure that the Safety Basis accident analyses can be revised and the SAR for the CVDF successfully updated. Additionally, a proposal to allow an increase in the residual water remaining in a MCO after drying would also require sufficient data to support a reanalysis of the Safety Basis for the CVDF. Alternative drying strategies to the CVD process must also be accompanied by sufficient data to support the development of the safety basis for the proposed process. It is anticipated that a ¼ to full-scale demonstration of a new process may be required to demonstrate the effectiveness of an alternative drying process.

Potential Life-Cycle Cost Savings of Need (in $000s) and Cost Savings Explanation: If the Spent Nuclear Fuel Project cannot complete the removal of fuel from the K-Basins and transfer it to dry interim storage by July 31, 2004, the project will incur additional costs of about $500K per day for each day over schedule.

Benefit to the Project Baseline of Filling Need: Acceleration of the fuel drying process is critical for meeting the project milestone commitments to complete the transfer of the K-Basin fuel to dry interim storage.

Relevant PBS Milestone: N/A

Functional Performance Requirements: Improvements to the CVD fuel drying process must be justified by sufficient data to support the revision of the Safety Basis for the process. Thus, data provided must be sufficient to support a stated hypothesis (e.g. a rise in the drying temperature of several degrees can be safely performed) with a stated statistical confidence factor that is based on data reproducibility, range of conditions, etc.

Similarly, any proposal for an alternative drying process must also be accompanied by sufficient data to support the development of a safety basis for the proposed process. Although laboratory-scale demonstration using surrogate spent fuel assemblies might be sufficient, it is anticipated that a ¼ to full-scale demonstration may be required to gather the data needed.

Work Breakdown Structure (WBS) No. TBD

TIP No.: TBD

***Justification For Need*:**

Technical: Acceleration of the process used to dry the fuel being removed from the K-Basins is essential to meet programmatic commitments and critical TPA milestones. Time can be saved in the drying process if the temperature of the process can be raised, but the data required to justify a temperature increase are not presently sufficient. Further, alternative-drying strategies may be possible to eliminate the need for vacuum drying of the majority of the fuel.

Regulatory: TPA milestone M-34-18B

Environmental Safety & Health: N/A

Cultural/Stakeholder Concerns: N/A

Other: DNFSB Commitment Number 118E

Current Baseline Technology: The current baseline technology used to dry the K-Basin fuel is described in the Problem Description section.

End-User: Cold Vacuum Drying Facility and Canister Storage Building Operations

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